

UNCLASSIFIED

AD NUMBER
AD056763
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to U.S. Gov't. agencies and their contractors; Operational and Administrative Use; Feb 1955. Other requests shall be referred to Air Force Armament Center, Air Research and Development Command, Eglin AFB, FL.
AUTHORITY
AFMC ltr, 19 Feb 2002

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

A 56763

Armed Services Technical Information Agency

ARLINGTON HALL STATION
ARLINGTON 12 VIRGINIA

CLASSIFICATION CHANGED FROM **CONFIDENTIAL**

TO Unclassified PER AUTHORITY LISTED IN

ASTIA TAB NO. U59-16 DATE 15 Aug 59

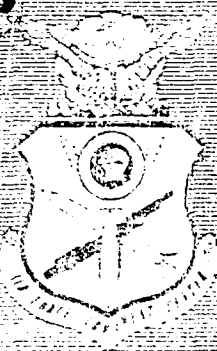
NO DRAWING, PHOTOGRAPH, OR OTHER DATA IS NOT TO BE REPRODUCED BY
REPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER
PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE,
USE, OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

UNCLASSIFIED

AFAC-TR-55-3

FL CONFIDENTIAL

AD 56763



AFAC

technical report

- Evaluation of Aircraft -
Armament Installation
(F-86F with 206 RK Guns)
Project Gun-Val (Title Unclassified)

- February 1955

AIR FORCE ARMAMENT CENTER
Air Research and Development Command
EGLIN AIR FORCE BASE, FLORIDA -

Copy No.

MAR 3 1955

55 AA

8016

CONFIDENTIAL

CONFIDENTIAL

Evaluation of Aircraft-Armament Installation (F-86F with 206 RK Guns)

Project Gun-Val

(Title Unclassified)

PUBLICATION REVIEW

This report has been reviewed and is approved.



WILLIAM G. DAVIS
Colonel, USAF
Deputy Commander

**AIR FORCE ARMAMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
Eglin Air Force Base, Florida**

February 1955

CONFIDENTIAL

55 A A 8016

CONFIDENTIAL

The following people were responsible for the actual testing accomplished under this project and for the preparation of this report. The Project Officer prepared the manuscript for this report.

Project Officer	Charles A. Heins, Jr., 2d Lt, USAF
Operational Test Officer	W. S. Snyder, 1st Lt, USAF
Project Analyst	Mr. Kenneth S. Cook
Technical Support Member	Mr. Herbert Benjamin
Data Programming Members	Mr. Nick Kormanik
	Miss Georgine Sirmon
Project Technician	S/Sgt William D. Garrett, USAF
Technical Editor	Mrs. Carolyn M. Allmon
Technical Illustrator	Mrs. Marie Greene
Repro Copy and Layout	Mrs. Frances Vaughn

CONFIDENTIAL

CONFIDENTIAL

FOREWORD

This test, Air Force Armament Center Project E/WM/20-4, RDO No. R555-719, was conducted as a part of Project Gun-Val under authority from Headquarters, Air Research and Development Command, Test Directive No. 5033-E1, dated 13 May 1952.

CONFIDENTIAL

CONFIDENTIAL**ABSTRACT**

An engineering evaluation was made of the Oerlikon 206 RK 20mm four-gun armament installation in an F-86F aircraft. The gun was fired from a rigid ground mount and from a stationary aircraft to determine barrel life, projectile velocity, cyclic rate, dispersion, and aircraft installation reliability. The general functioning characteristics, reliability of the installation, and effectiveness of the gun-gas purging system were evaluated during 19 aerial missions at altitudes from 10,000 to 40,000 ft.

The installation failed to meet the Gun-Val standard of 2.8 stoppages per 1000 rounds; however, based on the firing of full ammunition components, the stoppage rate attributable to the gun alone was 1.70 per 1000 rounds and the percent fire-out was 84.4. The installation is considered to be marginally satisfactory.

The results of this test indicate that the engineering principles employed in the design of the 206 RK gun are sound. The retractable firing pin is the outstanding feature of the gun. Dispersion of the gun when fired from the aircraft is unsatisfactory. Cyclic rate of fire met design specifications; muzzle velocity was slightly below the specifications. Compressor stall, flame-out, or variations in engine performance may be expected at high altitudes with this configuration. Muzzle flash is excessive. The gun-bay ventilating system is satisfactory.

The 20mm SS/K ammunition in its present design is unsuitable for use with the 206 RK gun. The ammunition link is unsatisfactory. The link ejection chutes and the ammunition feed chutes are satisfactory; however, the case ejection chute latches do not provide a positive means of securing the ejection chuting to the gun.

The following modifications should be made and tested if the 206 RK gun is to be considered for future installations: improvements in ammunition, links, gun, and gun parts should be made to decrease the over-all stoppage rate and extend gun parts life; blast panels on front upper gun of aircraft should be extended to prevent damage to the skin of the aircraft during firing; a more satisfactory lock for case ejection chutes should be designed; the weight of the gun should be reduced; and barrel adapters should be improved to reduce gun dispersion.

CONFIDENTIAL

CONFIDENTIAL

TABLE OF CONTENTS

	Page
FOREWORD	iii
ABSTRACT.	iv
INTRODUCTION	1
DESCRIPTION	1
206 RK Gun	1
Installation.	3
INSTRUMENTATION.	5
Ground Firing Phase.	5
Aerial Firing Phase.	5
TEST PROCEDURE AND RESULTS.	7
Rigid Ground Mount Phase	7
Barrel Life and Projectile Velocity	8
Cyclic Rate	9
Aircraft Ground Firing Phase.	9
Dispersion.	9
Cyclic Rate	9
Installation Reliability	9
Aerial Firing Phase.	11
Gun-Gas Analysis	11
Installation Reliability	11
Temperature and Humidity Cycling.	13
Muzzle Flash	13
Sight Reticle Vibration	14
Effects of Gun Firing on Aircraft.	14
Chuting.	16
Over-All Reliability	16
Parts Life	17
Ammunition	20
Maintenance	20
CONCLUSIONS	21
RECOMMENDATIONS	22

CONFIDENTIAL

CONFIDENTIAL

LIST OF ILLUSTRATIONS AND TABLES

Figure		Page
1	20mm 206 RK Gun	2
2	20mm 206 RK Gun Disassembled	2
3	The 206 RK Guns Installed in F-86F Aircraft. . . .	3
4	View Showing Upper Right Gun Pivoted for Maintenance and Lower Right Gun in Normal Position	4
5	View of Compartment With Fire-Eye Amplifier and Oscillograph Installed.	5
6	Gun-Gas Analysis Sampling Bottles Mounted in Left Gun Bay	6
7	Location of Fire-Eye Indicators (1 and 3) and Gun-Gas Pick-Ups (2 and 4) in Aft Portion of Right Gun Bay.	7
8	Flash Reducer Used with 206 RK Gun	14
9	Muzzle Flash at Start of Burst	15
10	Muzzle Flash of Great Intensity and Long Duration	15
11	Distant View with Excessive Muzzle Flash on Far Side and with Normal Flash on Near Side.	15
12	Damaged Slide	18
13	Damaged Gas Pistons	19
14	View Showing Cracks in the Gas Cylinder Bracket After Firing 1286 Rounds	19
15	Case Extractors	20

Table

1	Causes of Stoppages During All Phases of Testing .	8
2	Results of Dispersion Firing From Aircraft on Ground.	10
3	Summary of Aerial Missions	12
4	Gun Part Failures During the Firing of 6601 Rounds	17

CONFIDENTIAL

CONFIDENTIAL**INTRODUCTION**

This test was initiated as a part of "Gun-Val," a project which was designed to determine, from a variety of foreign and domestic guns installed in USAF aircraft, the most desirable armament combinations for various types of fighter missions. The gun under test was developed and produced by the Oerlikon Machine Tool Works, Buehrle and Co., Switzerland, under contract with Wright Air Development Center.

The purpose of this test was to evaluate four 20mm, 206 RK guns, installed by North American Aviation, Inc., Inglewood, California, in an F-86F aircraft. The evaluation was to be based upon stoppage rate, fire-out percentage, cyclic rate, dispersion, maintenance requirements, parts replacement rate, adequacy of the purging system, and the performance of the complete installation.

DESCRIPTION**206 RK GUN**

The Oerlikon 20mm 206 RK revolver gun (Figs. 1 and 2) is an automatic, gas-operated aircraft weapon, adaptable to either fixed or flexible mounting. It was designed to fire electrically-primed, link-belt-fed ammunition at a muzzle velocity of 3500 ft per sec and at a cyclic rate between 1600 and 1800 rounds per minute.

A five-chambered drum at the rear end of the barrel is rotated in steps by means of a gas-operated slide which successively aligns each chamber with the barrel. The cartridges, held in hook-and-eye type links, are pulled into the gun by a star wheel feeder that rotates with the drum. The rounds are then chambered into the drum by a two-stage rammer attached to the slide. The round is fired electrically when it reaches the 12-o'clock position. After the drum has rotated another step, a finger-type extractor engages the rim of the

CONFIDENTIAL

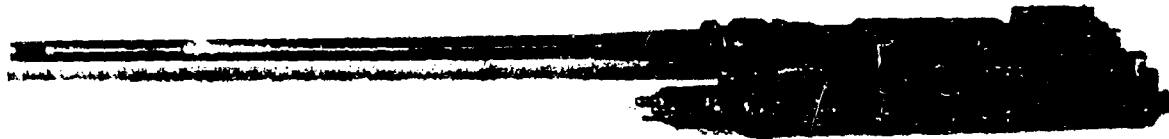


Fig. 1: 20mm 206 RK Gun

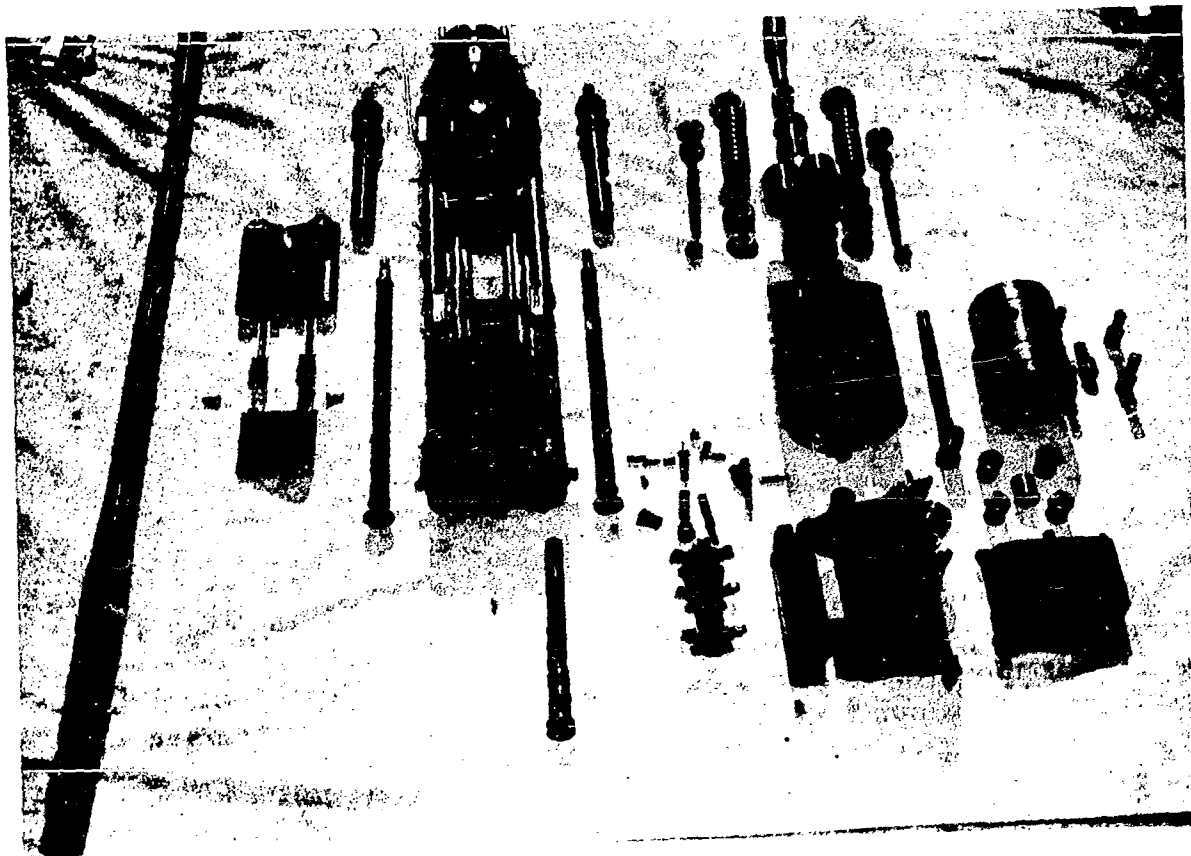


Fig. 2: 20mm 206 RK Gun Disassembled

CONFIDENTIAL

CONFIDENTIAL

empty cartridge. The ejector, cammed by a control rod of the reciprocating slide, propels the case to the rear as the slide begins to move.

The over-all length of this weapon with flash reducer is 94 in., without flash reducer, 86 1/2 in; height is 9 in.; width is 10 in.; and weight, including barrel, is 243 lb.

INSTALLATION

Four 206 RK guns are mounted in the F-86F test aircraft, two on each side of the fuselage (Fig. 3). Provision is made for the storage of 400 rounds (100 rounds per gun) of linked ammunition. Expended links are retained in the aircraft in order to minimize the movement of the center of gravity of the aircraft. Case ejection chutes are used to eject the expended cases from the aircraft.

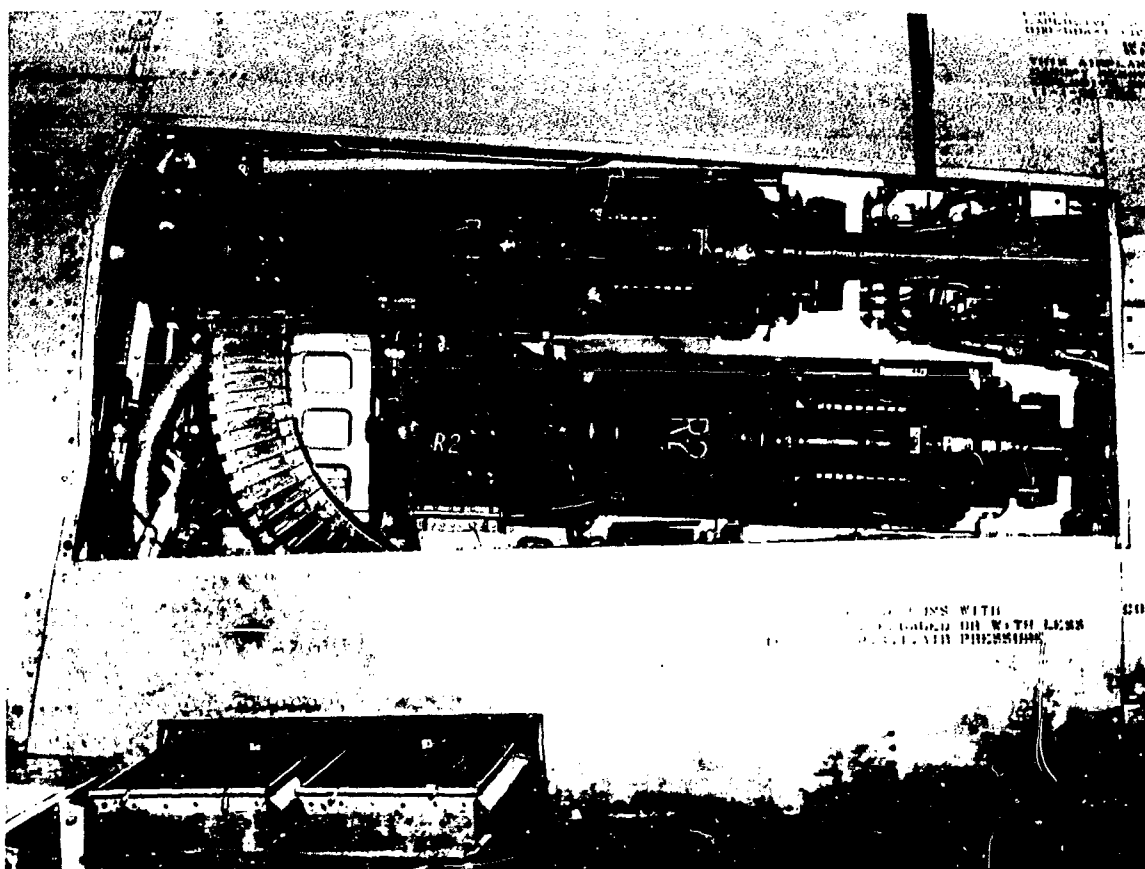


Fig. 3: The 206 RK Guns Installed in F-86F Aircraft

CONFIDENTIAL

CONFIDENTIAL

Each of the two gun bays is equipped with a gun-gas purging system consisting of a pneumatically-operated, electrically-actuated, air inlet door which opens into the engine air intake duct and acts as a ram air scoop when fully opened. The inlet doors open upon depression of the firing trigger and remain open for 5 sec after trigger release. Exits for the gun gas are provided by six vertical slots in each gun bay door. Additional ventilating holes are provided in the fuselage skin in the link retention compartment doors.

Access to the guns is facilitated by a mounting yoke at the forward end of the receiver. After the barrels are removed and the rear mounting lugs loosened, the gun can be pivoted as shown in Fig. 4 and serviced in that position.

The ammunition used during this test was the 20mm SS/K practice round with steel case.

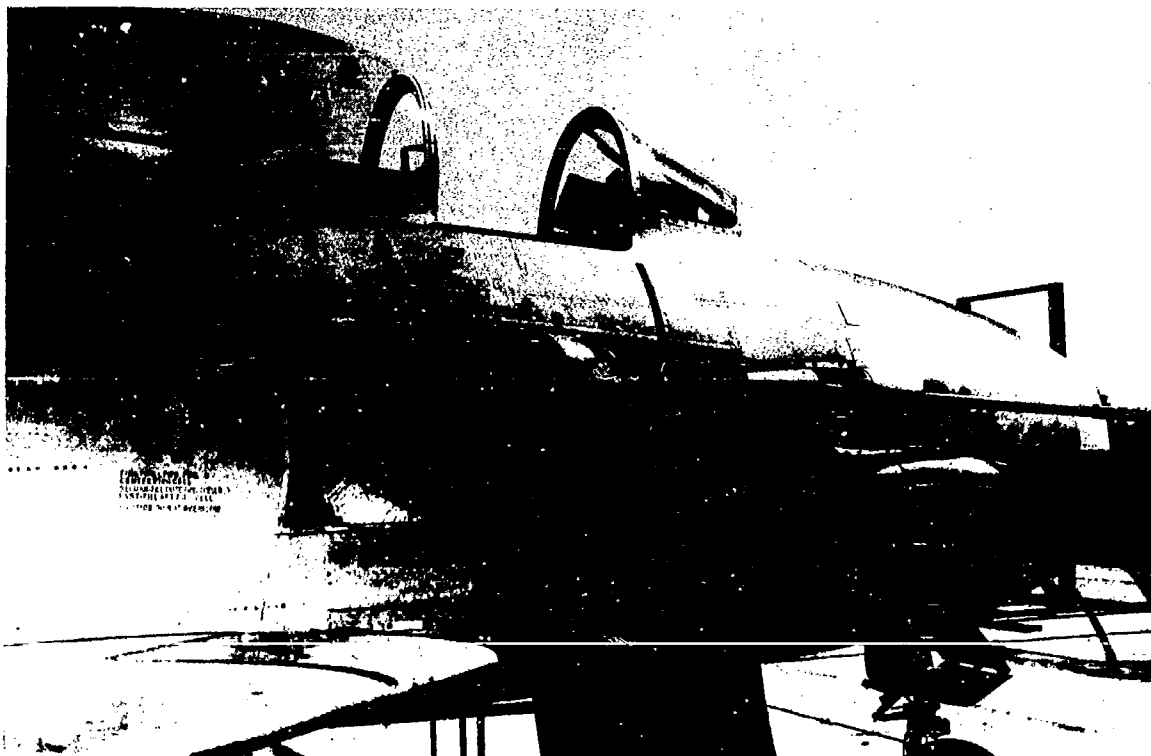


Fig. 4: View Showing Upper Right Gun Pivoted for Maintenance and Lower Right Gun in Normal Position

CONFIDENTIAL**INSTRUMENTATION****GROUND FIRING PHASE**

Cyclic rate of fire was determined by using a Brush recorder Model BL-206 and a Midwestern Model 555 oscillograph. Both instruments were actuated by pulses from the firing circuit. Instrumental velocity was recorded on a counter-chronograph, which measured the time required for a projectile to pass through two lumeline screens 50 ft apart.

Dispersion patterns were obtained from targets placed 1000 in. from the muzzles of the guns.

AERIAL FIRING PHASE

A 16mm GSAP camera was located in each wing tip of the test aircraft to provide photographic coverage from forward of the nose to just aft of the protrusion of the gun barrels. A third GSAP camera was located on the head rest above the pilot's left shoulder to provide coverage of the portion of the instrument panel which included altimeter, air-speed indicator, and g meter. A fourth GSAP camera, mounted on the sighthead of the A-4 gun sight, was used to record sight reticle vibration.



Fig. 5: View of Compartment With Fire-Eye Amplifier and Oscillograph Installed

CONFIDENTIAL

CONFIDENTIAL

Instrumentation to record cyclic rate of fire of each gun was installed in the test aircraft. A resistor, in series with the firing circuit, was used to create a voltage drop which could be recorded by a Midwestern Model 555 oscillograph (Fig. 5).

For the gun-gas phase of this test, two guns in the left gun bay were removed to furnish space for the vacuum bottle gun-gas sampling system. The system consisted of eight brass bottles, mounted as shown in Fig. 6. Individual sampling tubes were placed, one from each bottle, at locations in the right gun bay where it was considered that the greatest gas concentrations were likely to occur.

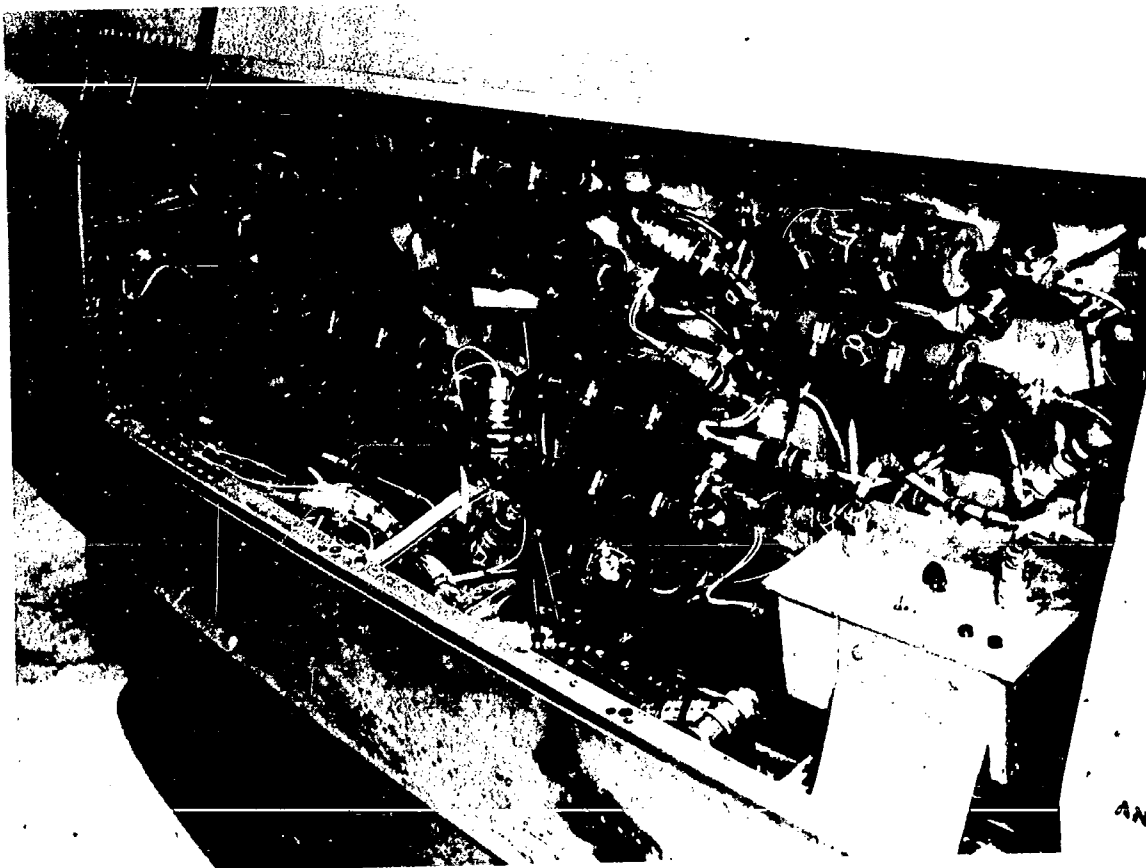


Fig. 6: Gun-Gas Analysis Sampling Bottles Mounted in Left Gun Bay

A photoelectric-cell fire detection system (fire-eyes) consisting of eight cells (four in each gun bay) was installed to determine when flaming occurred. The output signal of the fire-eye was amplified and recorded on the oscillograph. Two of the fire-eye indicators are shown in Fig. 7.

CONFIDENTIAL

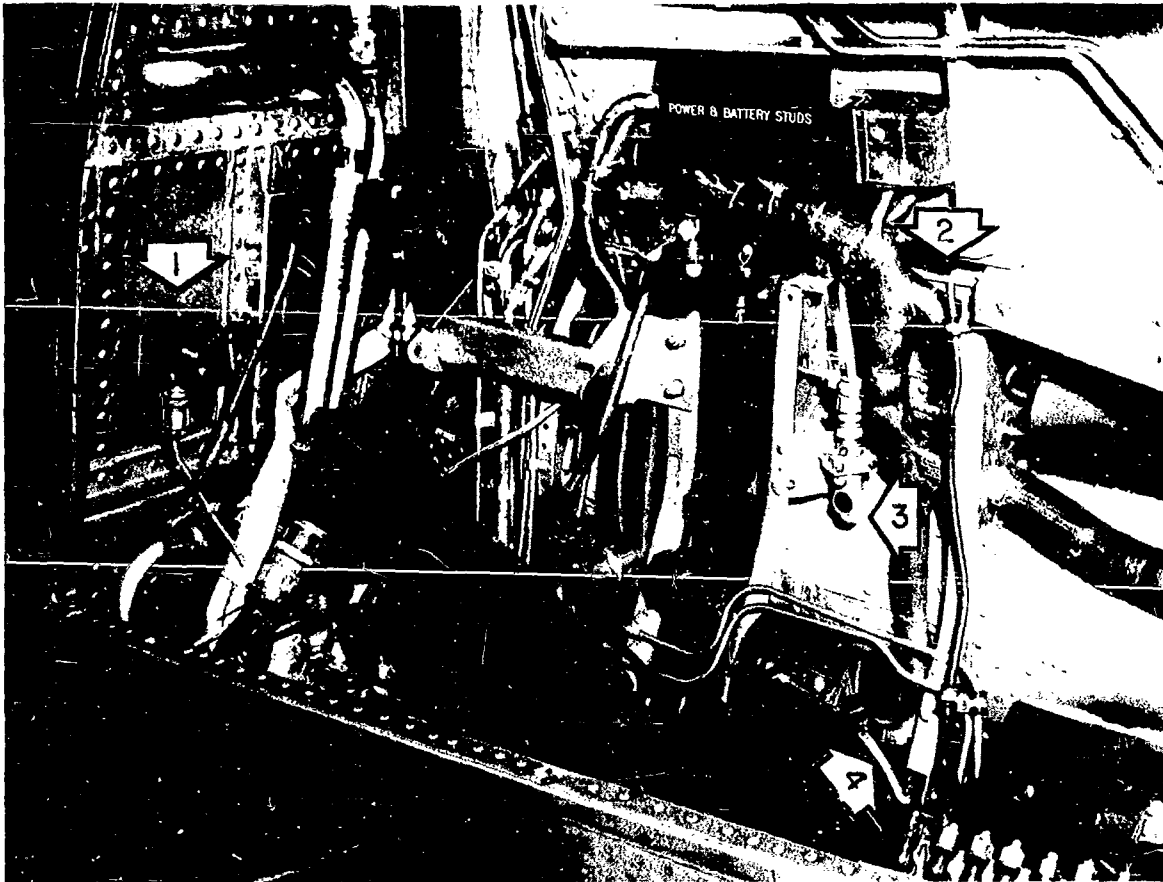
CONFIDENTIAL

Fig. 7: Location of Fire-Eye Indicators (1 and 3) and Gun-Gas Pick-Ups (2 and 4) in Aft Portion of Right Gun Bay

TEST PROCEDURE AND RESULTS

RIGID GROUND MOUNT PHASE

The rigid ground mount was used to obtain barrel life, projectile velocity, and cyclic rate of the weapon. A total of 321 rounds were loaded and 304 were fired, resulting in three stoppages which were due to a blown primer damaging the firing pin insulation, a second-stage round retainer failing to hold a dummy round, and a debulleted dummy round (see Table 1). The percentage of fire-out for this phase was 94.7, with an over-all stoppage rate of 9.87 per 1000 rounds and a gun stoppage rate of 3.29 per 1000 rounds.

CONFIDENTIAL

CONFIDENTIAL

TABLE 1. CAUSES OF GUN STOPPAGES DURING ALL PHASES OF TESTING

	Ground Phase		Aerial Phase		Total
	Rigid Mount	Aircraft on Ground	Gun Gas	Reliability	
Ammunition					
Defective primer	1	1		2	4
Debulleted round	1	3	1	2	7
Gun					
Broken contact rail lead		1		1	2
Failure of round retainer	1	1	1	1	4
Deformed slide				2	2
Defective interrupter switch				1	1
Broken extractor				1	1
Shorted firing circuit, caused by shavings from cases of rounds		1			1
Links					
Weak links				5	5
Installation					
Unlocked case ejection chutes		1		1	2
Personnel					
Improper maintenance			1	1	2
Undetermined			1		1
TOTAL STOPPAGES	3	8	4	17	32
Total Rounds Fired	304	1635	936	3526	6601
Over-all Stoppage Rate (stoppages per 1000 rnd)	9.87	4.36	4.27	4.82	4.85
Gun Stoppage Rate (stoppages per 1000 rnd)	3.29	1.63	1.07	1.70	1.67

Barrel Life and Projectile Velocity. Maximum barrel life is considered to have been reached when the projectile velocity drops 200 fps from the initial value of a new barrel or when a projectile yaw of 15° or greater occurs.

Projectile velocity and yaw checks for barrel life were taken after every two aerial missions during which the guns were fired in one and two second bursts. Each velocity determination consisted of an average

CONFIDENTIAL

of five shots spaced one minute apart after a warm-up burst of five rounds. The instrumental velocity of the projectile was computed from the measured time required for the projectile to pass through two luminescent screens spaced 50 ft apart, the first of which was located 25 ft in front of the muzzle of the gun. Projectile yaw was checked by placing a target at 1000 in. in front of the muzzle of the gun.

Velocity checks were made on each of four barrels. Results from two barrels indicated that there was no appreciable drop in projectile velocity as a result of firing 440 rounds. The average instrumental velocity for these barrels measured at 50 ft from the muzzle was 3376 fps. The other barrels were replaced after 379 and 397 rounds due to cracked orifices. Yaw results were not recorded on these four barrels at this time.

Using four new barrels for yaw checks, results showed that 100% yawing (90°) occurred on two of the barrels after 220 and 269 rounds with no indication of any decrease in initial projectile velocity.

Cyclic Rate. Cyclic rate of fire of this gun on the rigid ground mount was determined by firing a 25-round burst through each of four barrels. The average cyclic rate was 1825 rounds per minute with a maximum variation of 0.27%.

AIRCRAFT GROUND FIRING PHASE

A total of 1835 rounds of ammunition was fired from the F-86F test aircraft for the purpose of obtaining data on installation reliability, dispersion, and cyclic rate. The aircraft was placed on jacks and secured for this test phase.

Dispersion. Dispersion patterns were obtained by firing 20-round burst at targets placed 1000 in. from a point on the aircraft which represented the average gun muzzle location. The guns were fired both in salvo and singly. Results are shown in Table 2.

Cyclic Rate. Cyclic rate was recorded throughout the dispersion test phase. The average cyclic rate for salvo firing and single gun firing was 1656 and 1662 rounds per minute, respectively.

Installation Reliability. Installation reliability was assessed during the dispersion test phase. A total of 1986 rounds was loaded and 1835 rounds fired, resulting in a 92.5% fire-out. Eight stoppages

CONFIDENTIAL

CONFIDENTIAL**TABLE 2. RESULTS OF DISPERSION FIRING FROM AIRCRAFT
ON GROUND**(20-Round Bursts
Targets at 1000 in.)

Gun	Standard Deviation (mils)		Radius 50% Circle (mils)	Diameter 80% Circle (mils)
	Vertical (S _y)	Lateral (S _x)		
<u>Guns Fired Singly</u> (Based on the average of 5 bursts)				
Upper Right	3.83	4.07	4.66	14.21
Lower Right	5.08	5.62	6.31	19.25
Upper Left	5.65	4.64	6.08	18.55
Lower Left	3.59	3.80	4.35	13.28
<u>Guns Fired in Salvo</u> (Based on the average of 5 bursts)				
Upper Right	3.49	3.78	4.28	13.07
Lower Right	3.63	4.04	4.51	13.77
Upper Left	4.10	3.57	4.52	13.78
Lower Left	4.58	5.25	5.80	17.81
NOTE: All values of R ₅₀ and D ₈₀ were computed using the following equations:				
$R_{50} = 1.177 \frac{(S_x^2 + S_y^2)^{\frac{1}{2}}}{2}$				
$D_{80} = 3.59 \frac{(S_x^2 + S_y^2)^{\frac{1}{2}}}{2}$				

CONFIDENTIAL

CONFIDENTIAL

occurred, three of which were attributed to the gun, giving an over-all stoppage rate of 4.36 per 1000 rounds fired and a gun stoppage rate of 1.63 per 1000 rounds fired. The gun stoppages were the result of the second stage round retainer failing to hold a round, a shorted firing circuit due to steel cartridge case shavings, and a broken lead from the contact rail (this lead was broken by gun-firing vibrations). Of the remaining stoppages, four were caused by the ammunition and one by the installation (Table 1).

AERIAL FIRING PHASE

Gun-Gas Analysis. Eight Aerial missions were conducted to determine the effectiveness of the gun-bay ventilating system at altitudes of 10,000 and 40,000 ft at indicated air speeds of 140 to 500 knots (Table 3). Before each mission, eight brass sampling bottles were evacuated to 29 in. of mercury vacuum prior to their installation in the aircraft. Preflight checks were also made of the fire-eye indicators, oscillograph, and all cameras.

The two guns in the right gun bay were loaded (65 rounds each) and fired in one burst. One and one-half seconds after the start of firing, a timing device opened the vacuum bottle petcocks to allow for the collection of gun gases. This method of gun-gas detection gave no conclusive results for the eight missions conducted.

During the eight gun-gas flights, the fire-eyes installed in the gun-bays gave no indication of gun-bay fires. However, during one of the reliability and muzzle-flash flights (mission No. 15) gun-bay fires occurred. On this mission, the guns were fired in two 50-round bursts. During the first burst, the fire-eye opened 1.73 sec after the start of firing and remained open for 3 sec after trigger release. On the second burst, the fire-eye opened 1.50 sec after start of firing and remained open 0.20 sec after trigger release. These were the only gun-bay fires that were encountered during the aerial missions.

Installation Reliability. The reliability of the installation was determined during the eight gun-gas missions and 11 reliability missions. During the eight gun-gas missions, 1036 rounds were loaded and 936 rounds were fired, resulting in a 90.4% fire-out. Four stoppages occurred, giving an over-all stoppage rate of 4.27 per 1000 rounds fired. Only one stoppage was attributed in the gun, giving a gun stoppage rate of 1.07 per 1000 rounds fired (Table 1).

CONFIDENTIAL

CONFIDENTIAL

TABLE 3. SUMMARY OF AERIAL MISSIONS

Mission No.	Purpose of Mission	Altitude (ft)	Indicated Air Speed (knots)	Rounds Loaded Per Gun	Rounds Fired				"g" Loading	Remarks
					Upper Right	Lower Right	Upper Left	Lower Left		
1	Gun Gas	10,000	500	64	64	64	--	--	+1	Double charging caused only 64 rounds loaded.
2	Gun Gas	10,000	500	64	42	64	--	--	+1	Double charging caused only 64 rounds loaded. Dent appeared in nose of aircraft.
3	Gun Gas	10,000	150	65	16	65	--	--	+1	Dent came out of nose.
4	Gun Gas	10,000	150	65	65	65	--	--	+1	
5	Gun Gas	40,000	285	65	65	65	--	--	+1	
6	Gun Gas	40,000	283	65	65	65	--	--	+1	
7	Gun Gas	40,000	140	65	65	65	--	--	+1	Dent reappeared in nose. Dent came out of nose.
8	Gun Gas	40,000	145	65	39	62	--	--	+1	
9	Reliability	15,500	275	100	100	100	4	55	+1	
10	Reliability	25,000	350	100	21	76	100	100	+3	
11	Reliability	35,000	240	100	100	38	100	28	+3	Pilot did not fire-out guns.
12	Reliability	17,500	300	100	94	100	100	100	-1.8	
13	Reliability	35,000	250	Indicated as fired	0	66	67	71	+2.5	
14	Reliability	17,500	400	100	20	89	73	100	+5.2 to +6.1	Dent reappeared in nose.
15	Muzzle Flash and Reliability	34,600	255 and 160	100	100	91	100	94	+1	Dent came out. Compressor stall. Fire in gun bays.
16	Muzzle Flash and Reliability	10,000	200	100	23	100	100	97	+1	Dent reappeared, cracking skin.
17	Reliability	30,000	300	94	94	94	94	94	+5 to +7	
18	Temperature and Humidity Test and Reliability	40,000	255	100	100	100	100	63	+1	Start of a compressor stall.
19	Temperature and Humidity Test and Reliability	40,000	250	100	100	99	100	81	+1	

* Firing occurred at this altitude.

CONFIDENTIAL

CONFIDENTIAL

The eleven reliability missions were conducted at altitudes from 10,000 to 40,000 ft and under -1.8 to +7 g-loading conditions. For these aerial missions, each of the four guns was loaded with a full ammunition complement of 100 rounds (except missions 13 and 17) and fired in one and two-second bursts. A total of 4180 rounds was loaded for the aerial reliability missions and 3526 rounds were fired, giving an 84.4% fire-out. Seventeen stoppages occurred, giving a stoppage rate of 4.82 per 1000 rounds fired (Table 1). Of the 17 stoppages, only six were attributed to the gun, resulting in a stoppage rate of 1.70 stoppages per 1000 rounds fired. The majority of the stoppages occurring under g-loading conditions were attributable to delinked rounds (caused by weak links). No other adverse effects on gun performance and ammunition feeding resulted during firings under g-loading conditions.

Temperature and Humidity Cycling. In order to determine the effect of temperature cycling on the reliability of the installation, two missions (Nos. 18 and 19, Table 3) were conducted to permit the conditioning of the ammunition and installation at various altitudes. For mission No. 18, a 10-min conditioning was obtained at an altitude of 40,000 ft and another 5-min conditioning at 20,000 ft. The aircraft returned to 40,000 ft altitude at the maximum rate of ascent and remained at this altitude for 5 min before the guns were fired. On Mission No. 19, an 8-min conditioning was obtained at an altitude of 40,000 ft and another 1-min conditioning at 10,000 ft. The aircraft was then returned to 40,000 ft altitude at maximum rate of ascent, and the guns were fired immediately upon reaching altitude. The subjection of the installation to these temperature conditions had no adverse effect on the performance of the guns and their accessories.

Muzzle Flash. Two aerial missions, with flash reducers mounted on the guns (Fig. 8) were conducted at night to determine muzzle flash intensity. The intensity of the burning muzzle gases was excessive and impaired the vision of the pilot.

The muzzle blast of the gases at the start of the burst (Fig. 9) did not affect the vision of the pilot. However, the frequent ignition of the muzzle gases is of sufficient intensity and duration to affect the pilot's vision (Fig. 10).

Comparison of the intensity and volume of the ignited muzzle gases with the appearance of a gun muzzle flash before muzzle gas ignition is shown in Fig. 11.

CONFIDENTIAL

CONFIDENTIAL

Fig. 8: Flash Reducer Used with 206 RK Gun (Lower Arrow). Upper arrow shows dent which occurred on gun gas mission No. 2.

Sight Reticle Vibration. A sight camera was mounted on the sight-head of the A-4 gunsight and operated at 32 frames per sec to photograph the sight reticle vibration during eight reliability missions. Every third frame of the film was assessed to determine the magnitude of sight reticle vibration. The maximum amplitude of the pip from its normal position thus obtained was 20 mils. This does not necessarily indicate that greater amplitudes did not exist since the camera shutter speed was slower than the vibratory response of the reticle. It does indicate, however, that the maximum magnitude of vibration is not less than 20 mils.

Effects of Gun Firing on Aircraft. A secondary muzzle blast explosion, which occurred at 10,000 ft altitude, and 500 knots IAS (mission No. 2, Table 3), created a dent in the nose section forward of the upper right gun (Fig. 8). The dent remained in the nose section until the fifth aerial mission, conducted at 40,000 ft altitude, at which time the skin flexed into its normal contour. On subsequent flights at 10,000 ft altitude, the dent reappeared, and on aerial missions conducted at 40,000 ft altitude, the dent disappeared. After seven such flexures, the skin cracked (see the "Remarks" column, Table 3).

CONFIDENTIAL

CONFIDENTIAL

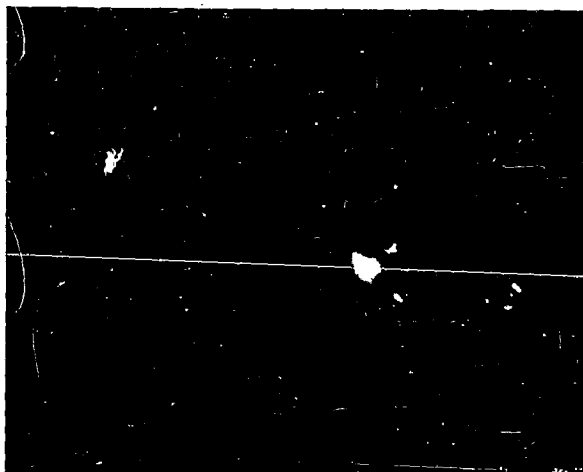


Fig. 9: Muzzle Flash at Start of Burst



Fig. 10: Muzzle Flash of Great Intensity and Long Duration

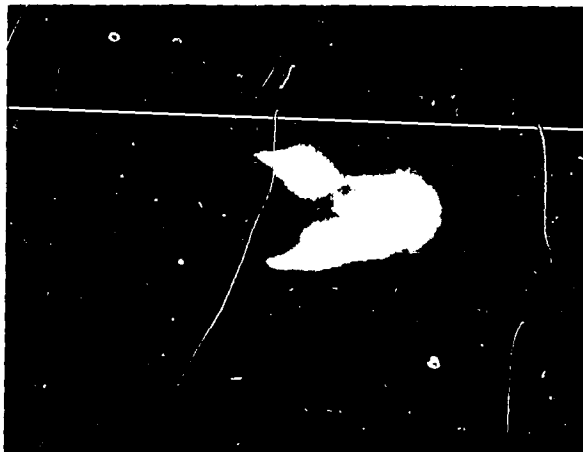


Fig. 11: Distant View with Excessive Muzzle Flash on Far Side and with Normal Flash on Near Side

CONFIDENTIAL

CONFIDENTIAL

One compressor stall and one partial compressor stall were encountered during the aerial test phase. The compressor stall occurred at 34,600 ft and at an indicated air speed of 160 knots. An increase in tail-pipe temperature to 900°C, associated with considerable aircraft vibration and a drop in rated rpm to 87% was experienced. The aircraft was put in a glide, and recovery was made at 32,000 ft.

The partial compressor stall was encountered at 40,000 ft and 250 knots IAS. The tail-pipe temperature rose to 800°C, and aircraft vibration was experienced. After completion of firing, recovery was effected easily by retarding the throttle to the idling position.

CHUTING

During two of the reliability missions, link jams occurred in the link ejection chutes of the upper guns. No stoppage occurred in either incident because the force exerted by the jammed links was sufficient to separate the chuting from the gun end adapter, thus permitting the subsequent links to be expended into the gun bay.

On five occasions, the aircraft case ejection chute of the lower guns became unlatched and separated from the feeders. Two stoppages resulted when the aircraft ejection chute obstructed the exit of the feeder case ejection chute. On the remaining three occasions, the ejection chutes of the aircraft cleared the exit of the feeder case ejection chute and permitted the expended cases to be extracted directly into the gun bay. No installation or gun damage resulted from the cases which were expended into the gun-bay compartment.

OVER-ALL RELIABILITY

A total of 7523 rounds of ammunition was loaded for the entire test and 6601 rounds were fired, resulting in an over-all fire-out percentage of 87.7. A total of 32 stoppages occurred during the entire test, resulting in an average over-all stoppage rate of 4.85 per 1000 rounds fired. (An installation stoppage rate of 2.8 per 1000 is considered acceptable under combat conditions.) Of these 32 stoppages, 11 were directly attributed to the gun, making the over-all gun stoppage rate 1.67 per 1000 rounds fired.

CONFIDENTIAL

CONFIDENTIAL

PARTS LIFE

After every two aerial missions or approximately 200 rounds in ground firing the guns were completely disassembled for cleaning, and worn or damaged parts were replaced. A list of the major gun parts that were replaced is given in Table 4. Drum roller springs and driving springs were replaced due to the permanent set they attained. The drive springs which were received in the gun were preset in length as much as 4 in.

TABLE 4. GUN PART FAILURES DURING
THE FIRING OF 6601 ROUNDS*

Part	No. of Failures
Drum Roller Spring	28
Driving Spring	17
Slide	16
Extractor	15
Gas Piston	12
Barrel	8
Spacer	8
Charging Cylinders	8
Barrel Orifice	7
Gas Piston Sleeve	6
Buffer Spring	5
Disk	3
Gas Cylinder Bracket	3
Rammer	2
Control Rod	1
Spring Support Pin	1
Recoil Spring	1
Total No. of Failures	141
* Each failure did not necessarily cause a gun stoppage	

After approximately 200 rounds had been fired, the slide became damaged by the gas piston (see Figs. 12 and 13). Only two stoppages were attributable to the slides (Table 1); in both instances the deformed slides prevented the drum from rotating.

CONFIDENTIAL

CONFIDENTIAL

Fig. 12: Damaged Slide

Metal fatigue, resulting from gun vibration, caused the gas cylinder brackets to crack (Fig. 14). This type of failure occurred in each of three guns after firing 1286, 1133, and 1321 rounds.

Fifteen case extractors were broken during the test; however, only one stoppage was attributed to this type of failure. The type of extractor breakage which occurred is shown in Fig. 15.

CONFIDENTIAL

CONFIDENTIAL

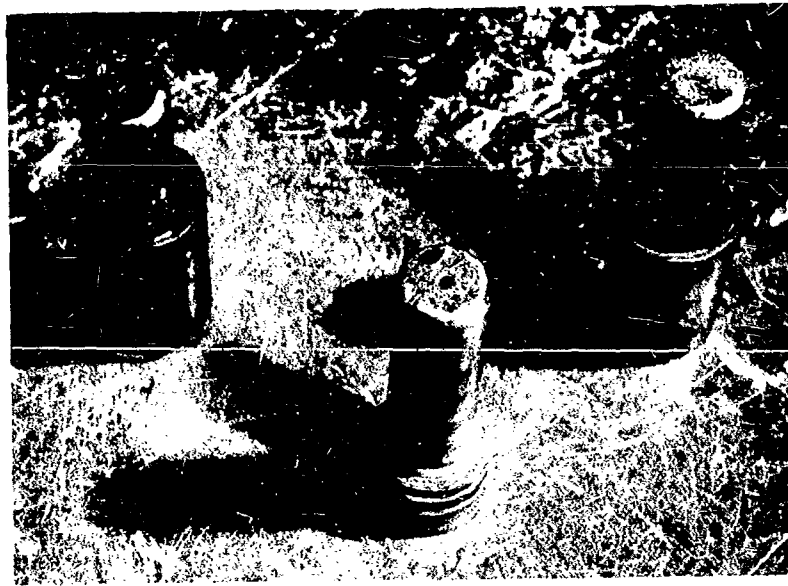


Fig. 13: Damaged Gas Pistons



Fig. 14: View Showing Cracks in
the Gas Cylinder Bracket After
Firing 1286 Rounds

CONFIDENTIAL

CONFIDENTIAL

The retractable firing pin is an outstanding feature of the weapon. The firing pin functioned perfectly under all flight conditions and no replacements for it were required during the entire test. The damage caused to the firing pin insulator was the result of blown primers.



Fig. 15: Case Extractors. First three damaged, last new.

AMMUNITION

Eleven stoppages were attributed to ammunition failure (Table 1). The inadequate bullet pull of the ammunition resulted in the debulleting of rounds during the ramming operation. Seven stoppages resulted from debulleted rounds and four were caused by blown primers. The number of stoppages attributable to ammunition is considered excessive.

MAINTENANCE

Maintenance on the guns can be easily accomplished once they are removed from the aircraft; however, they are heavy and difficult to handle during installation and removal. The aircraft gun mounts permit easy installation after the guns are raised to the proper height.

CONFIDENTIAL**CONCLUSIONS**

The 206 RK armament installation failed to meet the Gun-Val standard of 2.8 stoppages per 1000 rounds for an acceptable installation. However, based on the firing of full ammunition complements, the percent fire-out was 84.4 and the stoppage rate due to the gun alone was 1.70 per 1000 rounds fired. The performance of the 206 RK armament installation in the F-86F test aircraft is therefore considered marginally satisfactory.

Dispersion of the 206 RK gun fired from the aircraft was unsatisfactory. Cyclic rate of fire for the gun met design specifications; however, muzzle velocity was slightly lower than the specified values.

The results of this test indicate that the engineering principles employed in the design of the 206 RK gun are sound. Gun performance can be improved by strengthening the gas cylinder bracket, slide, extractor, drive springs, drum roller springs, and charging cylinders and redesigning the second stage round retainer.

The outstanding feature of the weapon is the retractable firing pin; no malfunctions of this component were encountered and no replacements for it were required during the entire test.

The average life of the gun barrel is approximately 250 rounds using 1 and 2-sec bursts.

Field servicing of this installation is difficult to accomplish because of the lack of space necessary to clear stoppages and to connect air lines to the charging cylinders of the two lower guns.

The 20mm SS/K ammunition in its present design is unsuitable for firing with the 206 RK gun. The primers are unreliable and the bullet pull of the ammunition is inadequate, permitting rounds to become de-bulleted during ramming operations.

The ammunition link used during this test is considered unsatisfactory.

Assembly and disassembly of the guns are easily accomplished when the gun is removed from the aircraft. Because of their weight the guns are difficult to install in or remove from the aircraft; however, the aircraft gun mounts permit easy installation of the gun in the aircraft after

CONFIDENTIAL

CONFIDENTIAL

the gun is raised to the proper height.

The gun-bay ventilating system is considered satisfactory since no gun-bay explosions occurred.

Flame-out, compressor stall, or variation in engine performance may be expected at high altitudes with this configuration.

Muzzle flash is considered excessive since it impairs the pilot's vision during night firing.

The link ejection chutes and ammunition feed chutes are satisfactory. The case ejection chute latches, however, do not provide a positive means of securing the ejection chuting to the gun.

RECOMMENDATIONS

If the 206 RK gun is considered for future installations, it is recommended that further tests be conducted with the aircraft-armament installation after the following modifications have been made:

1. Strengthening the gas cylinder bracket, slide, extractor, drive springs, charging cylinder assemblies and drum roller springs to improve parts life.
2. Redesigning the second stage round retainer to provide a more positive retaining action.
3. Reducing the weight of the gun.
4. Improving the reliability of the primers for the ammunition and increasing the bullet pull of the ammunition to prevent debulleting.
5. Improving the case ejection chute latches to provide a more positive means of securing the ejection chuting to the gun.
6. Strengthening the ammunition link to prevent the de-linking of rounds under g-loading conditions.

CONFIDENTIAL

CONFIDENTIAL

7. Extending the blast panels to the tip of the aircraft nose in front of the upper gun as is done for the lower gun to prevent damage to the aircraft skin.
8. Improving the barrel adapters in order to reduce gun dispersion.

If the 206 RK gun is considered for future installation, it is recommended that a study be made of its effect on engine performance.

CONFIDENTIAL

CONFIDENTIAL

INITIAL DISTRIBUTION

- | | |
|--|---|
| <p>1 Commander
Air Research and Development
Command
ATTN: RDTOIL (Tech Library)
P. O. Box 1395
Baltimore 3, Md.</p> <p>3 Commander
Air Research and Development
Command
ATTN: RDTDM
P. O. Box 1395
Baltimore 3, Md.</p> <p>10 Commander
Wright Air Development Center
ATTN: WCOST
Wright-Patterson AFB, Ohio</p> <p>8 Commander
Wright Air Development Center
ATTN: WCOSR (Req 2-1314
British)
Wright-Patterson AFB, Ohio</p> <p>8 Commander
Wright Air Development Center
ATTN: WCOSR (Req 2-2210)
Wright-Patterson AFB, Ohio</p> <p>5 Commander
Wright Air Development Center
ATTN: WCLG
Wright-Patterson AFB, Ohio</p> <p>3 Commander
Air Materiel Command
ATTN: MCGGP
Wright-Patterson AFB, Ohio</p> | <p>1 Director of Requirements
Headquarters USAF
Washington 25, D. C.</p> <p>1 Director of Operations
Headquarters USAF
Washington 25, D. C.</p> <p>1 Commanding General
Department of the Army
ATTN: OACofS, G-3
Washington 25, D. C.</p> <p>1 Deputy Chief of Staff, Materiel
Headquarters USAF
Washington 25, D. C.</p> <p>2 Director of R and D
Headquarters USAF
ATTN: AFDRD-AR
Washington 25, D. C.</p> <p>1 Naval Air Test Center
ATTN: Director, Armament Test
Patuxent River, Md.</p> <p>1 Commander
AF Cambridge Research Center
ATTN: CRQST-2
224 Albany St.
Cambridge 39, Mass.</p> <p>15 ASTIA, Document Service Center
Knott Building
Dayton, Ohio</p> <p>1 Technical Training Div
D/Training, DCS/Personnel
Headquarters USAF
Pentagon
Washington 25, D. C.</p> |
|--|---|

CONFIDENTIAL

CONFIDENTIAL

INITIAL DISTRIBUTION (Continued)

- | | |
|---|---|
| <p>1 Commander
Air Technical Intelligence Center
ATTN: AFOIN-ATISD-4B
Wright-Patterson AFB, Ohio</p> | <p>1 Commander
Air Materiel Command
Directorate of Procurement
and Production
ATTN: Mr. B. D. Haber
Aircraft Branch
Procurement Division
Wright-Patterson AFB, Ohio</p> |
| <p>10 Commander
Wright Air Development Center
ATTN: WCOSI-3
Wright-Patterson AFB, Ohio</p> | <p>1 AF Development Field Representa-
tive
Naval Air Test Center
Patuxent River, Md.</p> |
| <p>1 Commander
Lowry AFB
ATTN: TA and D
Denver, Colo.</p> | <p>1 Commander
Air Proving Ground Command
ATTN: DCS/Operations (TR)
Eglin AFB, Fla.</p> |
| <p>1 Commander
3499th Mobile Training Wing
Chanute AFB, Illinois</p> | <p>2 Commanding General
Air Research and Development
Command
ATTN: RDDRO
P. O. Box 1395
Baltimore 3, Md.</p> |
| <p>1 Aberdeen Proving Ground
Aberdeen, Md.</p> | <p>1 Commanding General
Air Proving Ground Command
ATTN: Directorate of Test
Requirements
Eglin AFB, Fla.</p> |
| <p>1 Commander
Air Research and Development
Command
ATTN: RDDR-RA
P. O. Box 1395
Baltimore 3, Md.</p> | <p>1 Office of the Chief of Ordnance
Department of the Army
ATTN: ORDTU, Mr. S. Swipp
Washington 25, D. C.</p> |
| <p>1 AF Plant Representative
North American Aviation, Inc.
Los Angeles 45, Calif.</p> | <p>1 Office of the Chief of Ordnance
Department of the Army
ATTN: ORDTR, Mr. A. Kramer
Washington 25, D. C.</p> |
| <p>1 Vitro Corporation of America
ATTN: Mr. A. J. Erickson
Eglin AFB, Fla.</p> | |
| <p>5 Commanding General
Wright Air Development Center
ATTN: Col. Florian A. Holm
Chairman, Gun-Val
Committee
Wright-Patterson AFB, Ohio</p> | |

CONFIDENTIAL

CONFIDENTIAL

INITIAL DISTRIBUTION (Continued)

- | | |
|--|--|
| <p>1 Commander
Naval Air Development Center
ATTN: AR-62
Johnsville, Pa.</p> | <p>1 Commander
Arnold Engineering Development
Center
Tullahoma, Tenn.</p> |
| <p>1 Commander
Air Proving Ground Command
Eglin AFB, Fla.</p> | <p>1 Commander
AF Flight Test Center
Edwards AFB, Calif.</p> |
| <p>2 Commander
Air Proving Ground Command
ATTN: Technical Reports Branch
Eglin AFB, Fla.</p> | <p>1 Commander
AF Missile Test Center
Patrick AFB, Cocoa, Fla.</p> |
| <p>3 Commander
Air Proving Ground Command
ATTN: Naval Liaison Office
Eglin AFB, Fla.</p> | <p>1 Commander
Rome Air Development Center
Griffiss AFB, Rome, N. Y.</p> |
| <p>1 Air Weapons Research Center
University of Chicago
ATTN: Col Paul E. Shanahan
Chicago 31, Ill.</p> | <p>1 Commander
AF Special Weapons Center
Kirtland AFB, Albuquerque, N. M.</p> |
| <p>2 Commander
Tactical Air Command
Langley AFB, Va.</p> | <p>1 Commander
Holloman Air Development Center
Holloman AFB, N. M.</p> |
| <p>2 Commander
Air Defense Command
Ent AFB, Colo.</p> | <p>1 Commander
Air Training Command
Scott AFB, Ill.</p> |
| <p>3 Commander
Strategic Air Command
ATTN: Operations Analysis
Director of Materiel
Director of Operations
Requirements Div.
Offutt AFB, Omaha, Neb.</p> | <p>1 Headquarters, WRAMA
ATTN: WRMT
Robins AFB, Ga.</p> |
| | <p>1 Director
Air University Library
ATTN: CR-4674
Maxwell AFB, Ala.</p> |
| | <p>1 The Rand Corporation
ATTN: Library
1700 Main St.
Santa Monica, Calif.</p> |

CONFIDENTIAL

CONFIDENTIAL

INITIAL DISTRIBUTION (Continued)

- 1 Commanding General
Picatinny Arsenal
ATTN: ORDBB-TE1, Mr. R.P. Swarts
Dover, N. J.
- 1 Armour Research Foundation
Illinois Institute of Technology
ATTN: Messrs Roy Smith and J. Pinsky
35 West 33rd St.
Chicago 16, Ill.
- 1 Commanding General
Rock Island Arsenal
ATTN: Mr. D. Meyers, Engineering Div.
Rock Island, Ill.
- 1 Commander
Naval Air Development Center
ATTN: Armament Lab
Johnsville, Pa.
- 1 Chief, Bureau of Ordnance
ATTN: Re8b, Mr. J. O. Watson
Department of the Navy
Washington 25, D. C.
- 1 Commander
Wright Air Development Center
ATTN: WCLGH-2, Mr. E. Ruyha
Wright-Patterson AFB, Ohio
- 1 Commander
Technical Training Air Force
Gulfport, Mississippi

CONFIDENTIAL



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

FEB 19 2002

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)
8725 JOHN J. KINGMAN ROAD, SUITE 0944
FORT BELVOIR VA 22060-6218

FROM: AFMC CSO/SCOC
4225 Logistics Avenue, Room S132
Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review,
AFMC 01-242 (Atch 1)

→ (b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review,
AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review,
AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

LEZORA U. NOBLES
AFMC STINFO Assistant
Directorate of Communications and Information

Attachments:

1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:
HQ AFMC/HO (Dr. William Elliott)



DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

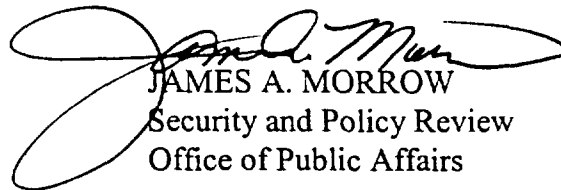
DEC 19 2001

MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 01-275

1. The reports listed in your attached letter were submitted for security and policy review IAW AFI 35-101, Chapter 15. They have been cleared for public release.
2. If you have any questions, please call me at 77828. Thanks.


JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

Attachment:
Your Ltr 18 November 2001

18 December 2001

MEMORANDUM FOR: HQ AFMC/PAX
Attn: Jim Morrow

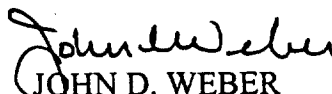
FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:
 - a. *Emergency Fuel Selector Valve Test on the J47-GE-27 Engine as Installed on F-86F Aircraft*, January 1955; DTIC No. AD- 056 013.
 - b. *Phase II Performance and Serviceability Tests of the F-86F Airplane USAF No. 51-13506 with Pre-Turbine Modifications*, June 1954; DTIC No. AD- 037 710.
 - c. *J-47 Jet Engine Compressor Failures*, 7 April 1952; DTIC No. AD- 039 818.
 - d. *Evaluation of Aircraft Armament Installation (F-86F with 206 RK Guns) Project Gun-Val*, February 1955; DTIC No. AD- 056 763.
 - e. *A Study of Serviced-Imposed Maneuvers of Four Jet Fighter Airplanes in Relation to Their Handling Qualities and Calculated Dynamic Characteristics*, 15 August 1955; DTIC No. AD- 068 899.
 - f. *Fuel Booster Pump*, 6 February 1953; DTIC No. AD- 007 226.
 - g. *Flight Investigation of Stability Fix for F-86F Aircraft*, 8 September 1953; DTIC No. AD- 032 259.
 - h. *Investigation of Engine Operational Deficiencies in the F-86F Airplane*, June 1953; DTIC No. AD- 015 749.
 - i. *Operational Suitability Test of the T-160 20mm Gun Installation in F-86F-2 Aircraft*, 29 April 1954; DTIC No. AD- 031 528.
 - j. *Engineering Evaluation of Type T 160 Gun and Installation in F 86 Aircraft*, September 1953; DTIC No. AD- 019 809.

AFMC 01-272

- k. *Airplane and Engine Responses to Abrupt Throttle Steps as Determined from Flight Tests of Eight Jet-Propelled Airplanes*, September 1959; DTIC No. AD-225 780.
- l. *Improved F-86F: Combat Developed*, 28 January 1953; DTIC No. AD- 003 153.
- m. *Flight Test Progress Report No. 19 for Week Ending February 27, 1953 for Model F-86F Airplane NAA Model No. NA-191*, 5 March 1953; DTIC No. AD-006 806.
2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.
3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.


JOHN D. WEBER
Command Historian

13 Attachments:

- a. DTIC No. AD- 056 013
- b. DTIC No. AD- 037 710
- c. DTIC No. AD- 039 818
- d. DTIC No. AD- 056 763
- e. DTIC No. AD- 068 899
- f. DTIC No. AD- 007 226
- g. DTIC No. AD- 032 259
- h. DTIC No. AD- 015 749
- i. DTIC No. AD- 031 528
- j. DTIC No. AD- 019 809
- k. DTIC No. AD- 225 780
- l. DTIC No. AD- 003 153
- m. DTIC No. AD- 006 806